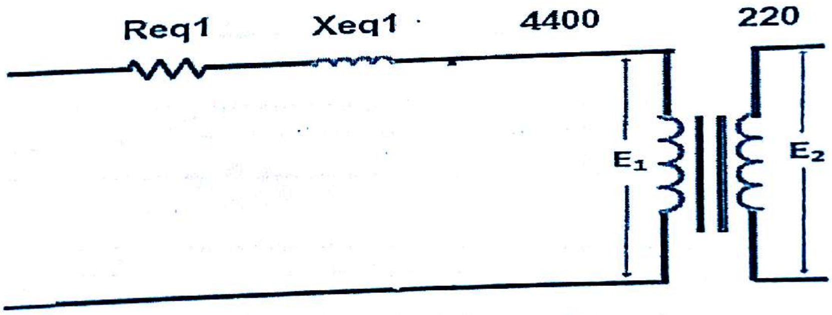
Tutorial#2
EE352

Q3

A 500KVA $4400/220V$ transform er has $R_1 = 3.45\Omega, R_2 = 0.009\Omega$. The values of reactences are $X1 = 5.2\Omega$ and $X2 = 0.015\Omega$ calculate for the transform er .(1) equivalent resistance as reffered to primary.(2) equivalent resistance as reffered to secondary. (3)equival ent reactances as reffered to primary and secondary. (4)Total Cu loss, First using indivisual resistance s of the two windings and secondly using equivalent resistance s as reffered to each side?

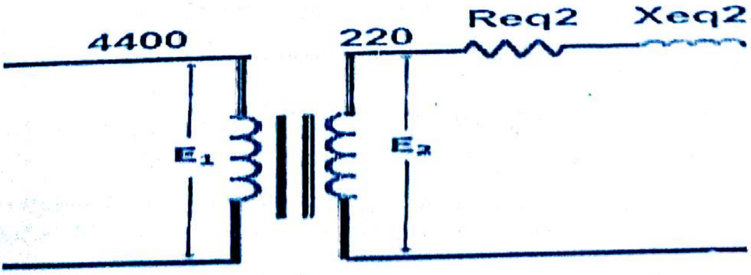
(1) reffered to Primary

$$R_{eq1} = 3.45 + 0.009\,(4400\ /\ 220\,)^2 = 7.05\,\Omega$$



(2)reffered to secondary

$$R_{eq2} = 0.009 + 3.45(220/4400)^2 = 0.0176\Omega$$



(3) *reffered* to primary .

$$X_{eq1} = 5.2 + 0.015 * (4400 / 220)^2 = 11.2\Omega$$

reffered to seconday .

$$X_{eq2} = 0.015 + 5.2 * (220 / 4400)^2 = 0.028\,\Omega$$

(4)

Cu loss $= I^2{}_1 R_1 + I^2{}_2 R_2$ where R_1, R_2 are primary and secondary resistances

$I_1 = 50000/4400 = 11.36A$ AT full load

$I_2 = 11.36*(4400/220) = 227A$

Cu loss $= 11.36^2 * 3.45 + 227^2 * 0.009 = 909\,watt$

Other solution

Cu loss $= I^2{}_1 R_{eq1} = 11.36^2 * 7.05 = 909\,watt$

or Cu loss $= I^2{}_2 R_{eq2} = 227^2 * 0.0176 = 909\,watt$

Q4 A single-phase power system is shown in Figure 1. The power source feeds a 100-kVA 14/2.4-kV transformer through a feeder impedance of $40.0 + j150\ \Omega$. The transformer's equivalent series impedance referred to its low-voltage side is $0.12 + j0.5\ \Omega$. The load on the transformer is 90 kW at 0.80 PF lagging and 2300 V.

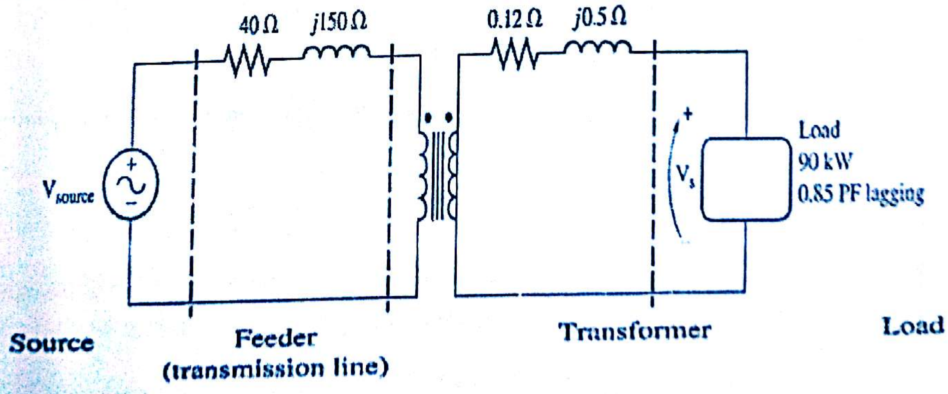


Figure 1

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(a) What is the voltage at the power source of the system?

(b) What is the voltage regulation of the transformer?

(c) How efficient is the overall power system?

Solution

To solve this problem, we will refer the circuit to the secondary (low-voltage) side. The feeder's impedance referred to the secondary side is

$$Z_{\text{line}}' = \frac{2.4\ \text{kV}}{14\ \text{kV}}^{2}\left(40\ \Omega + j150\ \Omega\right) = 1.18 + j4.41\ \Omega$$

The secondary current $\mathbf{I}_S$ is given by

$$I_S = \frac{90\ \text{kW}}{(2300\ \text{V})(0.85)} = 46.03\ \text{A}$$

$$\mathbf{I}_S = 46.03\angle -31.8^\circ\ \text{A}$$

(a) The voltage at the power source of this system (referred to the secondary side) is

$$\mathbf{V}_{\text{source}}' = \mathbf{V}_S + \mathbf{I}_S Z_{\text{line}}' + \mathbf{I}_S Z_{\text{EQ}}$$

$$\mathbf{V}_{\text{source}}' = 2300\angle 0^\circ\ \text{V} + (46.03\angle -31.8^\circ\ \text{A})(1.18 + j4.11\ \Omega) + (46.03\angle -31.8^\circ\ \text{A})(0.12 + j0.5\ \Omega)$$

$$\mathbf{V}_{\text{source}}' = 2467\angle 3.5^\circ\ \text{V}$$

Therefore, the voltage at the power source is

$$\mathbf{V}_{\text{source}} = (2467\angle 3.5^\circ\ \text{V})\frac{14\ \text{kV}}{2.4\ \text{kV}} = 14.4\angle 3.5^\circ\ \text{kV}$$

(b) To find the voltage regulation of the transformer, we must find the voltage at the primary side of the transformer (referred to the secondary side) under full load conditions:

$$\mathbf{V}_P' = \mathbf{V}_S + \mathbf{I}_S Z_{\text{EQ}}$$

$$\mathbf{V}_P' = 2300\angle 0^\circ\ \text{V} + (46.03\angle -31.8^\circ\ \text{A})(0.12 + j0.5\ \Omega) = 2317\angle 0.41^\circ\ \text{V}$$

There is a voltage drop of 17 V under these load conditions. Therefore the voltage regulation of the transformer is

$$\text{VR} = \frac{2317 - 2300}{2300} \times 100\% = 0.74\%$$

(c) The overall efficiency of the power system will be the ratio of the output power to the input power. The output power supplied to the load is $P_{\text{OUT}} = 90$ kW. The input power supplied by the source is

$$P_{\text{IN}} = V_{\text{source}}' I_S \cos\theta = (2467\ \text{V})(46.03\ \text{A}) \cos 35.3^\circ = 92.68\ \text{kW}$$

Therefore, the efficiency of the power system is

$$\eta = \frac{P_{OUT}}{P_{IN}} \times 100\% = \frac{90\ \text{kW}}{92.68\ \text{kW}} \times 100\% = 97.1\%$$